Elementary Teacher Perceptions of Hands-On Science Teaching in an Urban School System: The Greater Educational Context and Associated Outcomes

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Abstract

Forty-four elementary teachers in an urban school district were surveyed in order to (1) document teacher perceptions of various contextual factors in a school system undergoing large-scale science teaching reform, and (2) investigate the statistical relationships between teacher perceptions of the greater context of reform teaching and teacher perceptions of student and teacher outcomes. Correlation and regression analyses showed that both preparation time and opportunities for idea sharing helped explain changes in teacher confidence and student science interest; also, administrative support helped explain variations in time spent on teaching and teacher interest in science teaching. Many of the teachers' perceptions of the context of urban science reform were positive, although certain contextual problems were identified: some teachers had not been trained on the new curriculum, some teachers had not adopted the new curriculum, science kits were in need of restocking, and some teachers did not appear to be situated in a generally supportive local teaching context.

Key Words: urban education; science education; science teaching; teacher perceptions

Introduction

To promote deep conceptual understanding, science skill development, and positive attitudes toward science, it is recommended that science teaching and learning should be focused on the use of scientific reasoning and experimental procedures to investigate real-life phenomena (American Association for the Advancement of Science, 1994; National Research Council, 1996). Such “reform-based” instruction, however, can be the equivalent of a white-knuckle expedition through choppy waters, as many different factors can (and do) challenge the effectiveness with which teachers are able to implement a hands-on curriculum. To keep reform teaching smooth and on-course, science equipment and materials must be readily available, administrators must be willing to support science teaching reform efforts, assessments must be adjusted to meet the new goals of curricular reform, and ongoing professional development must be provided for the teachers involved (Bybee, 1995). These types of contextual supports are necessary components of successful educational reform because of the reality that education is a complex interaction of teachers, students, administrators, parents, school environment, curriculum, and materials – and therefore shortfalls or problems in any of these areas can have pronounced effects on the instruction that occurs in teachers’ classrooms.

Despite the inarguable influence of various contextual factors on science teaching and learning, there is still one key player that that has an immediate, overwhelming influence on the day-to-day details of curriculum implementation: the classroom teacher. While certainly constrained by classroom space, available equipment, the “assigned” curriculum, and administrative guidelines, the teacher is nonetheless relatively free to modify, adapt, improve, experiment, and motivate.

The way in which a given curriculum is interpreted, tinkered with, and (ultimately) implemented is not arbitrary, of course. Keys and Bryan (2001) firmly attribute such modifications/adaptations to the teacher’s own thoughts and opinions, as embodied in their conclusion that “curriculum reforms, however well meaning, are shaped and altered by teachers’ beliefs and understandings of the local context” (p. 635). Restated, Keys and Bryan are making the point that the notion of a “teacher-proof” curriculum is unrealistic; the way in which a given curriculum is enacted will necessarily vary – based on teachers’ individual beliefs and perceptions related to teaching, learning, and the instructional environment. Consequently, given the teacher’s prominent role in curriculum implementation, classroom teachers are necessarily at the heart of educational reform (Bybee, 1993; Lumpe, Czerniak, & Haney, 1999). Administrators and other stakeholders concerned with engineering a sweeping, effective, sustainable reform must be concerned with teacher perceptions in the district(s) in which reform is being attempted.

One example of a high-profile school system that has recently attempted to engineer systemwide reform is the Baltimore City Public School System (or BCPSS), the system that is the focus of this study. Three years ago, the BCPSS adopted a hands-on science curriculum for all elementary classrooms in the system, and the reform efforts have now reached a point where research is needed to document the teacher perceptions related to those the efforts. For this reason, the authors approached the BCPSS for the purpose of collecting data on: (a) teacher perceptions of the greater educational context of the BCPSS, to determine whether conditions are adequate to sustain the systemwide reform that has been attempted, and (b) relationships between contextual factors and student and teacher outcomes.

In this study, the following research questions were formulated to assess teacher perceptions of context and the relationships between context and outcomes:

- How do the teachers perceive the greater educational context of their hands-on science teaching?
- What relationships exist between the perceptions of the teachers' greater educational context, student learning, and changes in the teachers' practices and attitudes?

Different aspects of the teachers' educational context include administrative support, availability of materials, professional development in the school system, time available for planning and peer discussions, and a host of other factors.

Ultimately, there are two goals of the present research. The first goal is to provide teacher perception information to the BCPSS so that it can target specific contextual problems that might hamper the system's ongoing science reform efforts. The second goal is to document for the larger science education community the teacher perceptions of context, as well as the relationships between perceptions of contextual factors and outcomes, that are found in an urban school district attempting to reform its elementary-level science instruction.

Conceptual Framework and Prior Research

Although teacher practices, the greater context of teaching, and teacher attitudes and beliefs are inherently interconnected, for the sake of this paper we draw lines of separation between these three conceptual categories. Teacher practices are the actions and utterances that constitute the act of teaching. Teacher beliefs and attitudes are those affective stances and cognitive models that teachers possess with respect to teaching, learning, knowledge, science, their teaching environment, and so forth. The greater educational context is the large amalgam of factors and influences (outside the teacher) that affect teacher practice; this greater context includes the curriculum, the students, school culture, family support, and the district and state policy environment (Knapp, 1997).

A number of contextual factors have a significant impact on science teaching reform. Motz (1997) argues that, for science teaching reform to be effective and sustainable, certain contextual conditions must exist; these conditions include allocating the necessary teaching-hours to the reform curriculum, appropriate district budgeting, and an ongoing staff development program. Many of these issues are echoed by St. John, Century, Tibbitts, and Heenin (1984), who argue that a plan for successful science teaching reform must address the following questions: Is there appropriate vision and leadership? Is there appropriate professional support? Is there appropriate curricular and logistical support? Is there appropriate political and financial support? If these questions can be answered positively, then the plan for teaching reform has the strong potential to be long-reaching and sustainable.

Much of what we know about the factors that support or hinder science teaching reform are derived from educators' reflections on reform efforts that were briefly successful, and then abandoned – such as the relatively short-lived science-as-process teaching reforms from the 1960s and 1970s, which gave rise to such curricula as Elementary Science Studies (McGraw-Hill, 1968) and Science – A Process Approach (American Association for the Advancement of Science, 1963-1975). In these early reform efforts, teachers perceived many classroom-level challenges relating to reform teaching: assessment issues, equipment availability, safety, class management, and a focus on "basics" (Welch, Klopfer, Aikenhead, & Robinson, 1981). Unsurprisingly, many of these obstacles to science teaching reform are still in existence today. One such example is the case study by Keys and Kennedy (1999) of the science teaching of a practicing elementary teacher; the researchers found that challenges to the teacher's inquiry-based teaching included a lack of time, practical difficulties associated with the management and implementation of inquiry (e.g., turning student questions back over to the students), and the general constraint that some district-mandated concept standards are too abstract, and therefore cannot be taught through reform (inquiry) approaches.

Setting

The public school system chosen for this study was the Baltimore City Public School System (BCPSS). This urban school system contains 184 schools, 116 of which serve students in grades PreK-5. The population of the city of Baltimore is approximately 600,000. For the 2003-2004 academic year, ethnic demographics in the BCPSS were as follows: 87.2% African American, 11.2% Caucasian, 0.6% Asian, 0.6% Hispanic, and 0.4% American Indian. A majority of the families living in the area are economically disadvantaged, which is reflected in the high percentage (66.1%) of enrolled students who were eligible for free or reduced price meals during the year the study was conducted.

In an effort to bolster student learning, the system recently adopted the DiscoveryWorks book series (Badders, Bethel, Fu, Peck, Sumners, & Valentino, 2000) for use by all elementary level students. These curricula include modularized instruction in physical science, earth science, and life science. DiscoveryWorks activities consist primarily of hands-on activities that emphasize inquiry and investigation. It was hoped that the inquiry-based teaching style employed in the curricula would improve student retention of content and improve critical thinking skills.

In the BCPSS, science and social studies are taught in alternating 3-week blocks. Science is taught for 3 weeks, then social studies is taught for 3 weeks, then science is taught for another 3 weeks, and so on. During each science block, science is typically taught 3 days per week, one hour per day, for a total of 3 hours of science per week.

Methods

Data Collection

The BCPSS adopted the DiscoveryWorks (DW) curriculum as the official elementary level curriculum in 2001-2002. In 2002, we approached the BCPSS about conducting a survey on elementary teachers' perceptions of the greater context of urban science teaching – especially as it related to the implementation of the reform-based DW curriculum. BCPSS administrators agreed that the systemwide implementation of DW had reached a point where research on teacher perceptions would provide valuable feedback and data for the school system, and so the elementary science leaders and the BCPSS research office tentatively allowed the project to proceed. The final approval of the project came in the Fall of 2003, and our data was collected (via an on-line survey) in the Spring of 2004.

Generating the survey. Before adopting the DW curriculum, the BCPSS used an in-house elementary science curriculum (STARS) that had been collaboratively developed by teachers, administrators, and faculty from neighboring universities. A survey had been developed (Ukens, 1994) to evaluate the implementation and outcomes of the STARS curriculum project. We used the STARS survey as a starting point for our DW teacher perceptions survey, which was then significantly modified in order to meet the goals of this research project.

To ensure that the DW survey was appropriate and useful, our initial modifications to the survey were submitted to the BCPSS elementary science leaders for their feedback. Their feedback was then incorporated into the survey, with slight modifications. This process continued until all parties were in full support of the exact nature and content of the survey.

Survey overview. The entrance page to the DW on-line survey asked the elementary teachers whether they had been using the DW curriculum. If teachers responded that they had been using DW, they were passed on to the main body of the survey. If teachers responded that they had not been using DW, they were asked the name of the science curriculum that they had been using instead; the non-users of DW did not fill out the main body of the survey.

The 41-item DW teacher perceptions survey was broken into four sections:

- *Personal Data*: Respondents provided data on their years of teaching experience, their grade level taught, the number of DW units that they teach every year, and the percentage of each DW unit typically covered;
- *Factors Affecting Implementation*: Respondents used a Likert scale (strongly agree, agree, neutral, disagree, strongly disagree) to indicate the degree to which they agreed or disagreed with assertions relating to contextual factors and their beliefs about science teaching and the DW curriculum;
- *Changes in Classroom Practice and Professional Development*: Respondents used a Likert scale (increased substantially, increased a little, stayed about the same, decreased a little, decreased substantially) to indicate how their classroom practice, student outcomes, and professional development had changed since the teachers began using the DW curriculum; and
- *Free Response*: Respondents could include additional thoughts or comments about DW-based science teaching in the BCPSS.

For the purposes of analysis (see below), the multiple-choice survey questions were re-grouped into four conceptual categories. The survey, with conceptual groupings, can be found in the Appendix.

Recruiting survey respondents. To make elementary teachers aware of the DW teacher perceptions survey, information packets were sent to each elementary level principal within the BCPSS. These packets contained: (a) a letter that described the purpose of the research project, (b) informational flyers about the on-line survey for each elementary teacher in the school, and (c) a letter of support for the project from the BCPSS elementary science leaders and office of research.

Participants. In the Spring of 2004, the DW teacher perceptions survey appeared on-line for approximately 6 weeks. During that time, 51 elementary teachers responded to the survey. Of those, 44 stated that they used the DW curriculum in their classrooms. Six of the 7 non-users of DW did teach science, but not with the DW curriculum. The last responding elementary teacher did not teach science at all. Since this project was specifically directed at teacher perceptions related to DW implementation, only those responses from the 44 DW users were analyzed.

Data Analysis

Conceptual grouping of survey questions. As originally implemented, certain sections of the on-line survey contained a mixture of items pertaining to teacher beliefs, student learning, classroom practice, and various contextual factors. For the purpose of effectively investigating and answering our research questions, all 41 survey items were conceptually re-grouped into four different categories: (1) personal data (items P1 through P4), (2) items pertaining to teacher beliefs and knowledge (items T1 and T2), (3) items pertaining to the greater context of science teaching (items C1 through C19), and (4) items pertaining to student and teacher outcomes (items OC1 through OC15). The survey, with groupings, can be found in the Appendix. This re-grouping is in alignment with our conceptual framework, which makes a distinction between teacher beliefs/knowledge and the greater context of science teaching.

Internal consistency of the on-line survey. Responses to survey items were assigned numerical values as follows. For items C1 through C19 and OC1 through OC3, "strongly" disagree" was assigned a value of 1, "disagree" was assigned a value of 2, "neutral" was assigned a value of 3, "agree" was assigned a value of 4, and "strongly agree" was assigned a value of 5. Similarly, for items OC 4 thorough OC 15, "decreased substantially" was assigned a value of 1, "decreased a little" was assigned a value of 2, "stayed about the same" was assigned a value of 3, "increased a little" was assigned a value of 4, and "increased substantially" was assigned a value of 5.

Once all data had been collected, the internal consistencies for the contextual and outcomes groupings were calculated. Cronbach's alpha for the 20-item contextual factor grouping (with item C18 reverse-scored) was .89. Cronbach's alpha for the 15-item outcome grouping (with item OC2 reverse-scored) was .81.

Measuring teacher perceptions of the greater context of science teaching. To determine the teachers' overall perception of the greater context of science teaching in the BCPSS, we tallied the distribution of teacher responses to survey items C1 through C19 (i.e., the context grouping). "Strongly agree" and "agree" responses were collapsed into a single "agree" response, and "disagree" and "strongly disagree" responses were collapsed into a single "disagree" response.

Measuring the relationships between various contextual factors. For the sake of completeness, the on-line survey contained 19 separate items that were context-related (items C1 through C19); however, to reduce the large volume of data generated by the survey and keep our analysis focused, the authors and BCPSS personnel were most interested in investigating the interrelationships between textbook availability (C1), the degree to which activities work as intended (C3), the availability of supplies and equipment (C6), parental support (C9), time for teacher planning and preparation (C11), administrative support (C12, C13, C14), professional development (C15), and the sharing of ideas between teachers (C16). Relationships between these contextual factors were established by correlating these factors with one another.

Measuring the relationships between contextual factors and student and teacher outcomes. Although the survey assessed teacher perception of 15 separate outcomes (items OC1 through OC15), it was determined by the authors and BCPSS personnel – again, for the sake of data reduction and the need to keep our analysis focused – that certain outcomes would be more interesting and productive to analyze than others. Those outcomes were determined to be student learning (OC1), teacher interest in science teaching (OC6), student interest in science (OC7), classroom time devoted to science teaching (OC8), teacher knowledge of science concepts (OC11), and teacher confidence in his/her own science teaching (OC12).

Our method for establishing the relationships between certain contextual factors and the student and teacher outcomes was to correlate all contextual factors with each outcome, and then perform a stepwise linear regression analysis using the significantly correlating subset of contextual factors on that outcome. However, to prevent the regression analyses from becoming diluted with an overabundance of contextual factors, which might occur if all 19 contextual factors were utilized in the correlation/regression analyses, the large number of curriculum and administration items was reduced by calculating representative values for these items. Responses to the numerous curriculum items were transformed into a single representative "curriculum" response by averaging each teacher's responses to items C2, C3, C4, C5, C7, C8, and C10; likewise, responses to the different administrative items were transformed into a single representative "administrative support" response by averaging each teacher's responses to items C12, C13, and C14. In this manner, the set of 19 possible contextual factors was reduced to 11 factors (items C1, C6, C9, C11, C15 through C19, and the representative administrative support and curriculum responses) for use in the correlation/regression analyses.

Results

Results are broken into three sections: general information about the survey respondents, teacher perceptions of greater context of science teaching in the BCPSS, and relationships between contextual factors and outcomes.

General Information about the Survey Respondents

Teaching experience and grade level of responding elementary teachers. Thirty-nine percent of responding teachers (17 out of 44) had less than five years of teaching experience, 18% (8 out of 44) had between 5 and 8 years of teaching experience, and the remaining 43% (19 out of 44) had 9 or more years of teaching experience. Fifty-two percent of responding teachers (23 out of 44) were kindergarten, first, or second grade teachers, and the remaining 48% (21 out of 44) were third, fourth, or fifth grade teachers.

Teacher beliefs and knowledge. All 44 responding teachers agreed or strongly agreed with item T1: "Children need a hands-on science program". To assess their background knowledge in science, teachers were asked to rate the extent to which they agreed with item T2: "Before teaching DW, I had adequate content knowledge to effectively teach the lessons and activities". Fifty-five percent of the responding teachers (24 out of 44) agreed or strongly agreed with this statement, 25% (11 out of 44) were neutral, and the remaining 20% (9 out of 44) disagreed or strongly disagreed with this statement.

Teacher Perceptions of the Greater Context of Science Teaching

Over 75% of teachers were in agreement (either responding "strongly agree" or "agree") with items focusing on the ease of use, readability, and appropriateness of the written DW curriculum (items C2, C3, C4, C5, C7, C8, C10). At the same time, 57% of teachers (25 out of 44) were in agreement with item C18: "I frequently modify DW lessons because the lesson would not work or would not be feasible to complete in my classroom as written". Responses to all other contextual items are summarized in Table 1.

Table 1

Response Distributions for Particular Context-related Survey Items

Survey Item	Agree	Neutral	Disagree
DW textbooks are readily available in my classroom.	44	0	0
I have sufficient materials and supplies to implement DW lessons.	24	8	12
Parents are supportive of the DW curriculum.	11	23	10
I have adequate time to plan and prepare for instructional activities related to DW.	21	10	13

My school administration demonstrates a high priority for science.	16	15	13
My school administration has a clear understanding of how DW should be implemented.	16	17	11
The central administration actively supports the DW curriculum.	17	16	11
I have received professional development training specifically for DW.	26	1	17
I have had the opportunity to share teaching ideas about DW with other teachers.	25	8	11
I frequently modify DW lessons to meet the needs of diverse learners.	35	6	3
The noise level in my classroom is higher during DW lessons than during other parts of the day.	26	11	7

Note: "Strongly agree" and "agree" responses are jointly reported under "Agree". "Disagree" and "Strongly disagree" responses are jointly reported under "Disagree". $N = 44$ teachers.

Relationships between Teacher Perceptions of Different Contextual Factors

Correlations between the contextual factors of interest (outlined above) are presented in Table 2.

Table 2

Correlations between Particular Context-related Survey Items

	C1	C3	C6	C9	C11	C12	C13	C14	C15	C16
C1	--									
C3	.39**	--								
C6	.34**	.53**	--							
C9	-.09	.17	.33*	--						
C11	.34*	32*	.50**	.23	--					
C12	-.02	.26	.41**	.51**	.31*	--				
C13	.09	.22	.45**	.56**	.33*	.83**	--			
C14	.19	.16	.52**	.37*	.35*	.69**	.77**	--		
C15	.27	.38*	.49**	.24	.27	.40**	.53**	.46**	--	
C16	.09	.12	.21	.36*	.47**	.53**	.52**	.49**	.45**	--

Note: $N = 44$ teachers.
$^{*}p < 0.05$. $^{**}p < 0.01$.

Relationships between Teacher Perceptions of Context and Student and Teacher Outcomes

The factors that had a statistically significant correlation with student learning (item OC1) were the curriculum (measured by the average response to the curriculum survey items, as described above; $r = .56$, $p < .01$), administrative support (measured by the average response to the administrative support survey items, as described above; $r = .45$, $p < .01$), the availability of materials and supplies (item C6; $r = .31$, $p < .05$), parental support (item C9; $r = .54$, $p < .01$), professional development (item C15; $r = .43$, $p < .01$), and the sharing of ideas with other teachers (item C16; $r = .34$, $p < .05$). The result of the stepwise regression of these factors on student learning is shown in Table 3.

Table 3

Results of Regression of Contextual Factors on Student Learning

Contextual Factor	Cumulative R^2	ΔR^2	F-test	Significance
Curriculum	.32	.32	$F(1,42) = 19.3$	$p < .01$
Parental support	.49	.15	$F(1,41) = 19.4$	$p < .01$

Note. $N = 44$ teachers. Other factors did not contribute significantly to the cumulative R^2.

The factors that had a statistically significant correlation with teacher interest in the teaching of science (item OC6) were administrative support ($r = .50$, $p < .01$), the availability of materials and supplies (item C6; $r = .36$, $p < .05$), and the sharing of teaching ideas with other teachers (item C16; $r = .49$, $p < .01$). The result of the stepwise regression of these factors on teacher interest is shown in Table 4.

Table 4

Results of Regression of Contextual Factors on Teacher Interest in Science Teaching

Contextual Factor	Cumulative R^2	ΔR^2	F-test	Significance
Administrative support	.25	.25	$F(1,42) = 14.0$	$p < .01$

Note. $N = 44$ teachers. Other factors did not contribute significantly to the cumulative R^2.

The factors that had a statistically significant correlation with student interest in science (item OC7) were administrative support ($r = .40$, $p < .01$), parental support (item C9; $r = .49$, $p < .01$), time for planning and preparing (item C11; $r = .32$, $p < .05$), professional development (item C15; $r = .34$, $p < .05$), and the sharing of teaching ideas with other teachers (item C16; $r = .54$, $p < .01$). The result of the stepwise regression of these factors on student interest is shown in Table 5.

Table 5

Results of Regression of Contextual Factors on Student Science Interest

Contextual Factor	Cumulative R^2	ΔR^2	F-test	Significance
Sharing teaching ideas with others	.29	.29	$F(1,42) = 17.0$	$p < .01$
Time to plan and prepare	.39	.10	$F(1,41) = 13.2$	$p < .01$

Note. $N = 44$ teachers. Other factors did not contribute significantly to the cumulative R^2.

The factors that had a statistically significant correlation with time spent on science teaching (item OC8) were the curriculum ($r = .35$, $p < .05$), administrative support ($r = .43$, $p < .01$), the availability of materials and supplies (item C6; $r = .31$, $p < .05$), and parental support (item C9; $r = .41$, $p < .01$). The result of the stepwise regression of these factors on time spent on science teaching is shown in Table 6.

Table 6

Results of Regression of Contextual Factors on Time Spent on Science Teaching

Contextual Factor	Cumulative R^2	ΔR^2	F-test	Significance
Administrative support	.18	.18	$F(1,42) = 9.3$	$p < .01$

Note. $N = 44$ teachers. Other factors did not contribute significantly to the cumulative R^2.

The factors that had a statistically significant correlation with teacher content knowledge (item OC14) were administrative support ($r = .30$, $p < .05$), time for planning and preparing (item C11; $r = .34$, $p < .05$), and the sharing of teaching ideas with other teachers (item C16; $r = .41$, $p < .01$). The result of the stepwise regression of these factors on teacher content knowledge is shown in Table 7.

Table 7
Results of Regression of Contextual Factors on Teacher Content Knowledge

Contextual Factor	Cumulative R^2	ΔR^2	F-test	Significance
Sharing teaching ideas with others	.17	.17	$F(1,42) = 8.4$	$p < .01$

Note. N = 44 teachers. Other factors did not contribute significantly to the cumulative R^2.

The factors that had a statistically significant correlation with teacher confidence in his/her own science teaching (item OC15) were the curriculum ($r = .31$, $p < .05$), administrative support ($r = .43$, $p < .01$), time for planning and preparing (item C11; $r = .51$, $p < .01$), the sharing of teaching ideas with other teachers (item C16; $r = .50$, $p < .01$), and classroom noise (item C19; $r = 32$, $p < .05$). The result of the stepwise regression of these factors on teacher confidence is shown in Table 8.

Table 8
Results of Regression of Contextual Factors on Teacher Confidence

Contextual Factor	Cumulative R^2	ΔR^2	F-test	Significance
Time to plan and prepare	.26	.26	$F(1,42) = 14.5$	$p < .01$
Classroom noise level	.40	.14	$F(1,41) = 13.7$	$p < .01$
Sharing teaching ideas with others	.50	.10	$F(1,40) = 13.2$	$p < .01$

Note. N = 44 teachers. Other factors did not contribute significantly to the cumulative R^2.

Discussion

All 44 teachers using the DW curriculum responded that textbooks are readily available, which indicates that the BCPSS has done an effective job in supplying its elementary classrooms with texts. Also, as illustrated by the fact that 75% or more of the teachers responded positively to many of the curriculum-related survey items, teachers were generally happy with the use, readability, and appropriateness of the DW curriculum – although these responses are counterbalanced by the fact that 57% of teachers (25 out of 44) regularly felt the need to modify activities because they wouldn't quite work as written. This suggests that the DW curriculum is clearly written and well-organized, but perhaps the activity content and activity structure occasionally need fine-tuning – at least as perceived by the majority of teachers.

Teacher perceptions were decidedly mixed on the availability of equipment and supplies, as 45% of teachers (20 out of 44) fell into the neutral or disagreement category in their perception of whether there are enough materials and equipment to implement DW effectively. Similar results were found for planning and preparation time, with 52% of teachers (23 out of 44) responding neutrally or negatively toward the assertion that teachers have adequate time to plan and prepare. That the teachers would perceive a need for improved restocking procedures is fairly unsurprising, since science kit restocking is one of the known "perennial problems" of elementary science reform (Knapp, 1997, p. 239) – a problem, in fact, that was mentioned explicitly by four of the teachers in their free response comments. An equipment problem could conceivably lead to teachers abandoning a hands-on curriculum such as DW in favor of a curriculum less reliant on materials, and so the importance of equipment restocking as a crucial contextual support is one that cannot be overemphasized; the need for updated and refilled science kits is an action item that should be high on the to-do list for any reform effort, and a school system runs the risk of ignoring equipment restocking at the possible expense of the sustainability of their systemwide reforms. The other issue, the lack of sufficient planning and preparation time, has long been a contextual mainstay of the teaching profession – and is only unique in the sense that it is one of the few contextual factors in this study that is not science-specific.

The most striking variation in teacher perceptions related to context can be seen in the distribution of teacher responses with respect to administrative support, parental support, and professional development. Thirty percent of teachers disagreed with the notion that their school administration demonstrates a high priority for science, and 25% did not perceive the central administration to be supportive of DW. Over half of the teachers held a neutral perception concerning parental support, with 23% disagreeing that parents supported the DW curriculum. The array of responses most closely approaching a bimodal distribution is found in the professional development item, with 59% of teachers verifying that they had been trained on the DW curriculum and 39% indicating that they had not been provided any DW-specific training. The parental support result is difficult to interpret, because the survey does not contain a comparative item relating to parental support for other subjects – and so the teacher responses do not help us to determine whether parental support for DW is a problem specific to this hands-on science curriculum, or is more reflective of parental support in general.

There were likely a number of different reasons why certain teachers perceived a lack of administrative support for the DW curriculum, one aspect of which could be the fact that – not unlike many other urban school systems – the BCPSS tends to concentrate more on mathematics and language/reading than on science. An upcoming event that will likely impact the BCPSS administration's focus on science is the state's intention to officially assess science learning at all levels beginning in 2007. At that time, the extent, nature, and tone of BCPSS support for elementary science teaching may change – although whether administrative support driven by testing will have positive or negative effects on science reform is difficult to predict. In other school systems, for example, test-driven science reforms have had negative impacts on teachers' professionalism and teacher-student relationships (Settlage & Meadows, 2002).

A more immediate concern for the BCPSS is that over one-third of the survey respondents had not yet received professional development specifically related to DW, the official science curriculum. Given the established connection between curriculum-specific professional development, changes in teacher beliefs and practice, and the success of reform, an increase in curriculum-related training would be a logical step toward improving the potential for sustained educational change in the system.

On the general subject of DW adoption, one bit of data that deserves to be restated and emphasized is that, of the 51 teachers who originally responded to the survey, only 44 were actually using the district-mandated DW curriculum; six of the 51 (12%) used a different science curriculum, and 1 of the 51 (2%) did not teach science at all. This marks an area in need of improvement in the system, since the use of DW in 100% of classrooms is the administrative goal. Regardless, these percentages allow us some practical insight into the percentage of classrooms that end up adopting a mandated curriculum as the result of a systemwide reform effort.

The correlations between contextual factors, which are presented in Table 2, point to a number of interesting interrelationships in the greater educational context of urban science teaching. We highlight the most notable results by focusing on those statistically significant correlations that are .50 or higher. The correlation between items C3 and C6 reinforces what we already know about effective reform-based science teaching – that science activities work properly when there are sufficient materials available. The correlation between various teacher perceptions with administrative support may provide additional insight as to why teachers do or do not perceive the administration to be supportive. The correlations link the availability of materials, opportunities for sharing ideas with other teachers, and professional development with administrative support, all of which make a good deal of sense from the perspective of a practicing teacher; an indicator of explicit administrative support for a curriculum would include ongoing maintenance of that curriculum, as demonstrated by the devotion of money and effort toward equipment updates, peer mentoring, and continuous professional development. Other correlations point to interesting and important variations in perceptions of the greater context of teaching, such as the correlation between items C6 and C11, which indicates that teachers who perceive an availability of materials tend to feel that they also have sufficient time to prepare, whereas teachers who perceive a lack of materials tend to feel that their preparation time is less sufficient. This paints a picture where certain teachers appear to be in a generally supportive teaching context, whereas others seem to lack this contextual support. In this light, one goal of the system administration might be to provide guidance and support for the various elementary schools such that the local contexts can be made more uniform across the system, which would hopefully drive all teacher perceptions in a more positive direction.

Perhaps the most interesting results from this study are the links between particular contextual factors and perceived student and teacher outcomes. One example is the relationship between teacher perceptions of the curriculum and teacher perceptions of student learning – a relationship that is more complicated than it first appears. Since all 44 survey respondents are using the same curriculum (DW), albeit at different grade levels, one might wonder why perceptions of curriculum quality would vary from teacher to teacher. One possibility is that the DW curriculum varies significantly in quality by grade level or by unit, in which case an unevenness in curriculum quality would explain the perceived differences in learning. Another possibility is that teachers' ratings of the curriculum and student outcomes are influenced by their own beliefs about science teaching and learning; for example, those teachers who agree with the philosophy of the curriculum might perceive greater increases in student learning (whether or not they exist) as compared to those teachers who disagree with the curriculum philosophy. Determining the base explanation behind the relationship between curriculum perceptions and outcome perceptions is a non-trivial task that deserves further study.

Examining the other regression analyses, a key result is that the sharing of instructional ideas between teachers contributed significantly to the variance in three separate outcomes: perceived changes in student science interest, perceived changes in teacher content knowledge, and perceived changes in teachers' confidence toward their own science teaching. The prominence of idea sharing in these regression results gives credence to the notion that establishing a teacher mentoring and support network is a vital aspect of science reform. Planning and preparation time is yet another factor that contributes significantly to variance in perceived changes in teacher confidence and student science interest. One could imagine that teachers with adequate planning would be in a better position to provide students with a productive and interesting science experience, and would also tend to feel more positively about the flow, focus, and effectiveness of their own teaching practices. The statistical link between administrative support and perceived changes in both teacher interest in science teaching and time spent on science teaching suggests that the administration's visibility and helpfulness in the process of reform is not to be dismissed, as it appears that teacher perceptions of local and administrative support – as one might expect – can have a significant impact on teacher beliefs and classroom practice.

Conclusion

Each time another urban school system attempts large-scale science teaching reform, there is always the danger that the system lacks the contextual supports that are necessary for successful, sustainable changes in educational practice. One of the least effective methods of implementing systemic change is the "hope" approach – where the school system adopts a new reform-based curriculum, purchases equipment and books, trains teachers, and then hopes for the best (St. John, Century, Tibbitts, & Heenin, 1984). The proponents and engineers of change must instead focus not only on immediate practical necessities such as supplies and professional development, but must also focus on issues such as school culture, family involvement, and ongoing administrative guidance – for only by recognizing and addressing the complex relationships between greater context, teacher beliefs, and classroom practice do long-term changes in science teaching and learning become a reasonable possibility.

One purpose of the present study was to conduct basic research on the statistical relationships between teacher perceptions of the greater context of science teaching and teacher perceptions of various outcomes. It was found, for instance, that both planning time and the sharing of teaching ideas have strong links to changes in teacher confidence and changes in student science interest. Another result is that perceived administrative support helped to explain a significant amount of variance in both time spent on teaching and teacher interest in science teaching. Results such as these are meaningful and relevant because they reinforce the fact that contextual supports are important aspects of education that have a direct impact on teacher/student outcomes; additionally, these results provide insight into the particular types of contextual factors that have the greatest impact.

Another purpose of the present study, a purpose that was driven by our desire to provide practical services for schools, was to identify a neighboring urban school system in the midst of reform, document teacher perceptions of contextual supports in that system, and share those results with system administrators – so that previously unknown problems of teacher perception might be identified and addressed before they become hulking obstacles that slow or stop the science reform process. Despite this purpose, much of what was discovered in our investigation of the current state of BCPSS reform is quite positive. Classrooms are well-stocked with texts, the vast majority of teachers perceive the newly adopted curriculum to be well-organized and easy to use, and a full 100% of teachers surveyed believe that a hands-on curriculum is the best type of science curriculum for their students. However, there are also a handful of problems that could derail the process of reform if they go unchecked. These problems include the existence of a significant population of teachers who have not yet been trained on the new curriculum, a smaller population of teachers who have not yet adopted the new curriculum, a pressing need for the restocking of DW science kits, and notable differences across teachers in terms of their perceptions of administrative support and available supplies. We have shared our project results with BCPSS science leaders and administrators so that the above problems can begin to be addressed.

The final purpose of this study follows directly from the last. In addition to sharing the project results directly with the BCPSS, an underlying purpose was to share the results of our investigation with administrators and classroom teachers in other school systems. As there is no reason to think that the BCPSS is exotic or unique in its chosen plan for reform, the perception-related problems that we have identified with science reform in the BCPSS can serve as advance warnings for other urban school systems considering similar reforms. One thing that will never change is that the road to sustained educational reform is an overwhelming journey fraught with challenges, and that the agents of reform need support and information from all sides for their efforts to be successful.

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Author Note

Many thanks to Leon Ukens and Lisa Tirocchi for their comments on this manuscript.

Appendix

DiscoveryWorks Teacher Perceptions Questionnaire: Survey Items, by Conceptual Grouping

Throughout this questionnaire, the abbreviation "DW" stands for DiscoveryWorks.

Personal data.

P1. How many years of teaching experience do you have?
a. this is my first year b. 2 to 4 c. 5 to 8 d. 9 to 20 e. more than 20

P2. What is your current grade level? (Leave this item blank if you teach K)
a. 1st b. 2nd c. 3rd d. 4th e. 5th

P3. How many different DW units do you typically teach per year?
a. one b. two c. three d. four or more e. none

P4. In a typical DW unit, what percentage of the lessons/activities do you typically cover with your class?
a. about 10% b. about 25% c. about 50% d. about 75% e. about 100%

Items pertaining to teacher beliefs and knowledge.

T1. Children need a hands-on science program.
T2. Before I began teaching DW, I had adequate content knowledge to effectively teach the lessons and activities.

Items pertaining to the greater context of science teaching.

The following scale was used to respond to items C1 through C15.

A	B	C	D	E
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

C1. DW textbooks are readily available in my classroom.
C2. DW texts and lessons are written clearly.
C3. DW activities work as intended.
C4. DW units are appropriate for my students.
C5. DW materials and supplies are easy to use.
C6. I have sufficient materials and supplies to implement DW lessons.
C7. The DW lesson structure is easy for *teachers* to follow.
C8. The DW lesson structure is easy for *students* to follow.
C9. Parents are supportive of the DW curriculum.
C10. DW makes the role of the teacher clear as the students conduct the activities.
C11. I have adequate time to plan and prepare for instructional activities related to DW.

C12. My school administration demonstrates a high priority for science.
C13. My school administration has a clear understanding of how DW should be implemented.
C14. The central administration actively supports the DW curriculum.
C15. I have received professional development training specifically for DW.
C16. I have had the opportunity to share teaching ideas about DW with other teachers.
C17. I frequently modify DW lessons to meet the needs of diverse learners.
C18. I frequently modify DW lessons because the lesson would not work or would not be feasible to complete in my classroom as written.
C19. The noise level in my classroom is higher during DW lessons than during other parts of the day.

Items pertaining to student and teacher outcomes.

The following scale was used to respond to items OC1 through OC3.

A Strongly Disagree	B Disagree	C Neutral	D Agree	E Strongly Agree

OC1. DW makes a difference in student learning.
OC2. My current understanding of DW science content could be improved.
OC3. I have fewer discipline problems occurring during DW lessons than during other parts of the day.

The following scale was used to respond to items OC4 through OC15.

A Increased Substantially	B Increased a Little	C Stayed About the Same	D Decreased a Little	E Decreased Substantially

OC4. The average number of professional conferences (Maryland Association of Science Teachers, National Science Teachers Association, etc) in science education I attend per year has:
OC5. The number of hands-on science activities in my class has:
OC6. My own personal interest in teaching science has:
OC7. My students' interest in science as taught in school has:
OC8. The amount of time I devote to teaching science has:
OC9. The amount of time a visitor in my class would observe students doing science activities without my help has:
OC10. My involvement in science education outside of teaching DW (ex: science fairs, field trips, etc) has:
OC11. The number of times that student questions have led to student investigations has:
OC12. My use of cooperative learning as a teaching style has:
OC13. The amount of funds I have been able to obtain to teach science has:
OC14. My knowledge of science concepts has:
OC15. My confidence in teaching science has:

Free response.

F1. Please enter any other thoughts or comments you have about your experiences using the DiscoveryWorks curriculum.